IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

HEENAN, Sidney A., et al.

Serial No.: 09/453,327

Filed: December 2, 1999

For: RETROREFLECTIVE ARTICLES HAVING MICROCUBES, AND TOOLS AND METHODS FOR FORMING MICROCUBES

Examiner: J. Phan
Art Unit: 2872

I hereby certify that this correspondence is being deposited with the U.S. Postal Service as First Class Mail in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450 on August 18, 2003

Paulette Haseltine

PAULETTE HASELTINE

Honorable Commissioner of
Patents and Trademarks
Washington, D.C. 20231

DECLARATION OF DENNIS I. COUZIN

I, Dennis I. Couzin, do declare and state as follows:

1. I am a co-inventor of the above-identified patent application, and its issued patent, U.S. 6,015,214.

2. I am familiar with prior art patent U.S. 4,588,258 to Hoopman. The cube corner elements of the Hoopman patent are discussed in this application at col. 3, lines 29-40; at FIGS. 42A-E, 43 and the accompanying text at col. 20, line 49 - col. 21, lines 13; col. 25, lines 1-7, 37-41; col. 25, lines 67 - col. 26, line 12; col. 26, lines 21-28; and col. 30, lines 49-53.

3. I am also familiar with U.S. 5,138,488 to Szczech, which was cited by the Examiner in the Office Action of June 18, 2003 in this application. The Szczech and Hoopman patents have a common assignee. The cube corner elements of the Szczech patent have the same basic structure as those taught in the Hoopman patent.

4. The purpose of this declaration is to show that the cube corner elements illustrated in Figures 4A and 4B of the Szczech patent, are not canted edge-more-parallel.

Canted Triangular Cube Corner Elements

5. All the triangle cube corners in a single ruled array made from three groove sets will necessarily have the same cant. This is because all the cube corners in the array will have the same shape of base triangle, the shape produced by the directions of the three groove sets. Once the shape of the base triangle is determined, the shape of the whole cube corner is determined, because there is only one point above the plane of a triangle that, when connected to the triangle's three vertices, produces three mutually perpendicular lines. This point is the apex of the cube corner. Since the shape of the whole cube corner is determined, its cant is also determined.

6. Every cube corner has an axis, which is the line from its apex that makes equal angles with its three dihedral edges. Illustration 3 below shows the cube corner axis as a diagonal of the full cube of which the cube corner is one corner. A ruled triangular cube corner is uncanted if the cube axis is perpendicular to the plane of the triangular base. Otherwise the cube corner is canted. The amount of cant is measured as the angle between the cube corner axis and the perpendicular to the base plane. The kind of cant, namely, edge-more-parallel or face-more-parallel, depends on further features of the shape of the whole cube corner.

7. Illustration 1 below shows three triangular cube corners, each from a different ruled array, in plan view. This view shows the shape of the triangle, and in these examples, the kind of cant is evident from the shape of the triangle. The middle cube corner with the equilateral triangular shape is uncanted. Its axis is perpendicular to its base, so the axis doesn't show in the plan view. The left cube corner with the squat isosceles triangular shape, the triangle's two equal angles being less than 60°, is canted face-more-parallel. Its axis is visible in

the plan view. The right cube corner with the tall isosceles triangular shape, the triangle's two equal angles being greater than 60°, is canted edge-more-parallel. Its axis is visible in the plan view.

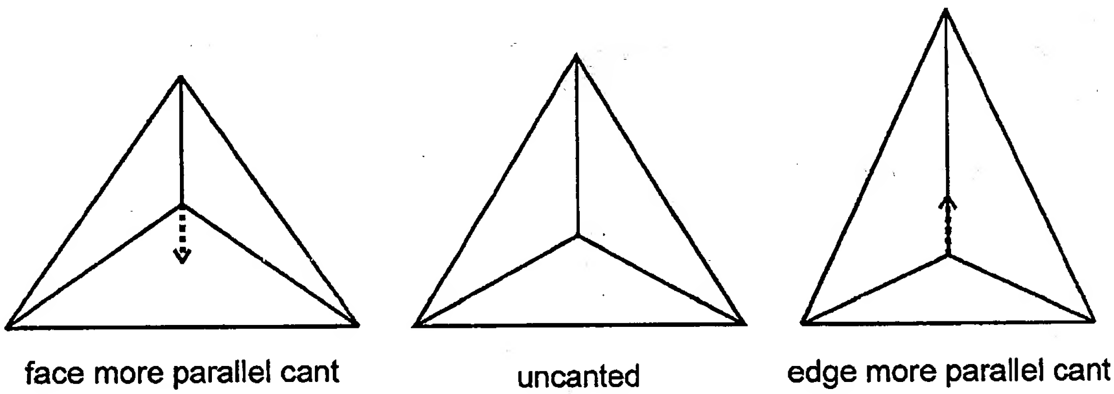

Illustration 1

8. Illustration 2 below shows the same three triangular cube corners of Illustration 1, but each rotated 90° in plan view. The bottom half of Illustration 2 is a sectional view of the three cube corners, the sectioning being on a line marked SS' which splits each isosceles triangle symmetrically. The horizontal line in each sectional view indicates the article front surface. In each cube corner in Illustration 2, a certain edge, aligned with the sectioning, is labeled 'e' and the face opposite it is labeled 'f'. For the isosceles triangular cube corners shown, canting the cube corner can be visualized as rocking the sectional view of the uncanted cube corner either clockwise or counterclockwise. Rocking the uncanted cube corner clockwise makes face f more parallel to the article front surface and creates the cube corner shown on the left. Rocking the uncanted cube corner counterclockwise makes edge e more parallel to the article front surface and creates the cube corner shown on the right. The sectional views are a useful mnemonic for the terms "face-more-parallel" and "edge-more-parallel". The more general definitions of 'face-more-parallel' and 'edge-more-parallel' cant in Heenan et. al, 6,015,214 at col. 9 line 19 are, when

applied to ruled isosceles triangular cube corners, consistent with this simple description of the two kinds of cant.

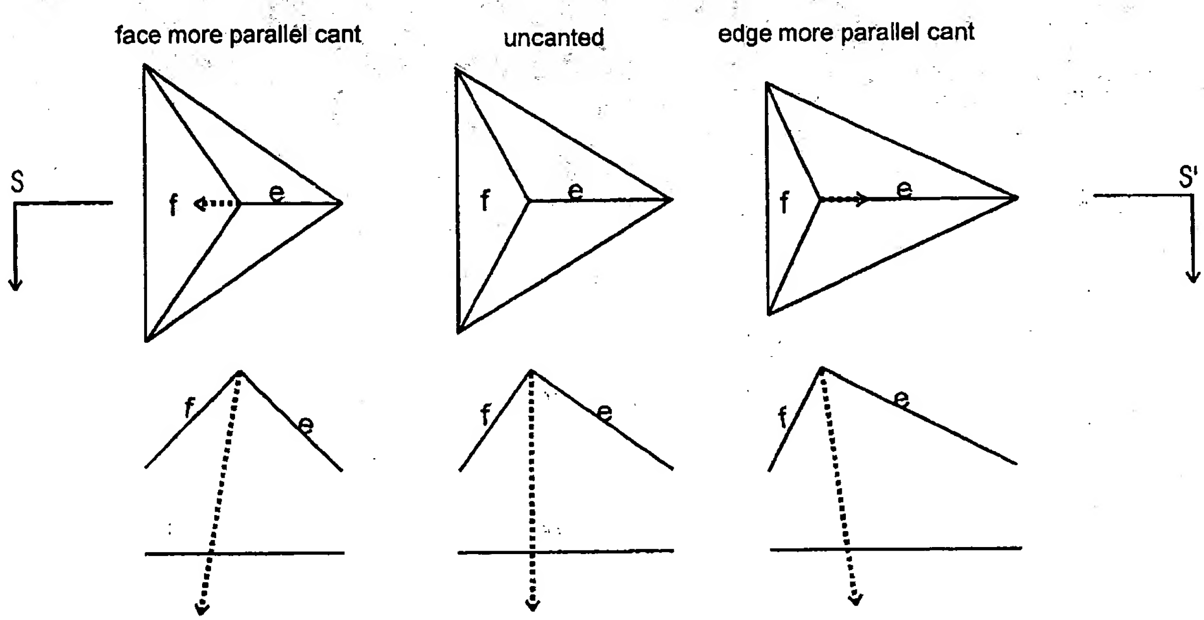

Illustration 2

9. Notice that the rocking changes the relative lengths of f and e in the sectional views in Illustration 2. This is because there is a constant ruling depth that determines the base plane of the triangular cube corner. The relative lengths of the lines labeled 'f' and 'e' in the sectional views thus indicate the kind of cant. In the ruled face-more-parallel canted cube corner, $1 \leq e/f < \sqrt{2}$. In the ruled uncanted cube corner, $e/f = \sqrt{2}$. In the ruled edge-more-parallel canted cube corner, $e/f > \sqrt{2}$.

The Disclosure of U.S. 5,138,488 ("Szczech '488")

10. Szczech '488 Figures 4A and 4B are sectional views each of a pair of cube corners from the ruled array of Figure 3 of the same patent. This alone implies, based on the discussion in paragraph 5 above, that all four cube corners, the two in 4A and the two in 4B have the exact

same cant or lack of cant. Figure 3 of Szczech '488 is a plan view of an array of cube corners having the squat isosceles triangular bases described in paragraph 7 above, so these cube corners are canted face-more-parallel.

11. Referring now directly to Figs. 4A and 4B of Szczech '488, one can identify the cube corners therein as face-more-parallel canted, without even having to identify which lines represent edges and which lines represent faces. Whichever is e, and whichever is f, Figures 4A and 4B show the length ratio e/f as being about 1. So the figures can neither represent $e/f > \sqrt{2}$ as required for edge-more-parallel cant, nor $e/f = \sqrt{2}$ as required for an uncanted cube corner. As explained in paragraph 9 above, since e/f is definitely less than $\sqrt{2}$, the figures must represent face-more-parallel canted cube corners.

12. Since Szczech '488 Figures 4A and 4B show the cube axis for each cube corner, we can in fact identify which line is face and which line is edge. The axis of every cube corner makes a 35.26° angle to all its dihedral edges, and makes a 54.74° angle to all its faces. Canting can't change this fact. It is a consequence of the basic geometry of a cube shown in Illustration 3 below. The 35.26° between the cube corner axis and a dihedral edge is so much smaller than the

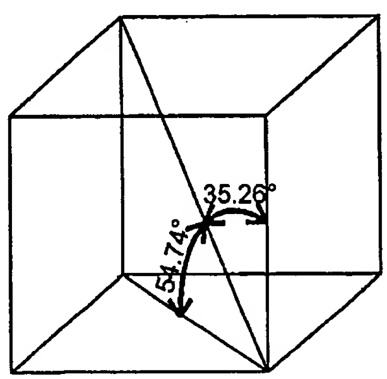

Illustration 3

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54.74° between the axis and a face that the difference is easily visible. In Szczech '488 Figures 4A and 4B, the cube axes are all identified by reference numeral 24. For each axis 24, the line with respect to which the axis makes the smaller angle (more nearly 35.26°) must represent a dihedral edge, and the line with respect to which the axis makes the larger angle (more nearly 54.74°) must represent a face. Below are reproduced the two figures with appropriate labels 'e' and 'f' added. With this labeling, each cube corner shows its face-more-parallel cant clearly. Each cube corner has its indicated face f more parallel to the article front surface than the face would be were there no cant.

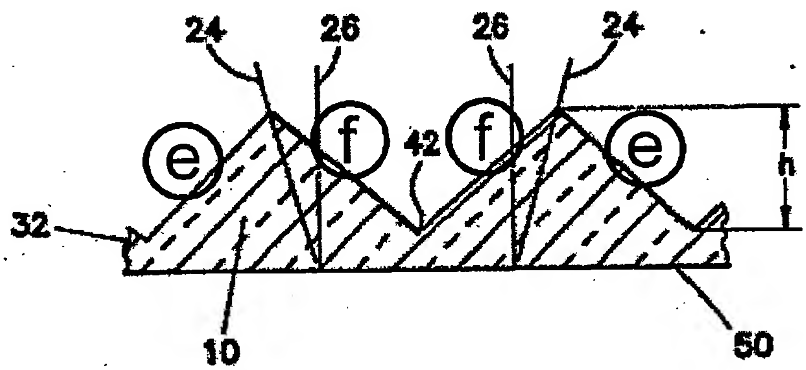

FIG. 4A

in Szczech 5,138,488 (circled letters added)

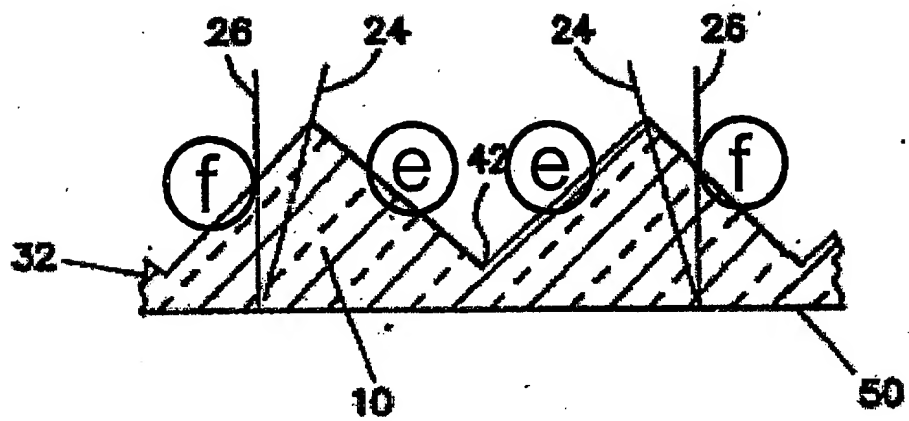

FIG. 4B

in Szczech 5,138,488 (circled letters added)

Cube Orientation

13. Throughout the above, methods are described for determining the cant of an individual cube corner. Each and every cube corner has its inherent cant and while the cant can be thought of as the result of a rocking in a sectional view (e.g. in Illustration 2), rotations of the cube corner in the plan view do not affect the cant. The orientation of a cube corner is distinct from its cant. For example, the left cube corner in Illustration 1 above has identical face-more-parallel cant as the left cube corner in Illustration 2 above. One cube corner has been rotated 90° with respect to the other in the plan view. Ruling arrays of triangular cube corners necessarily produces pairs of cube corners that are rotated 180° with respect to each other in plan view In each pair, both cube corners have identical cant, but opposite orientation. Szczech '488 Figure 3 shows an array of triangular cube corners. Szczech '488 Figures 4A, and 4B show pairs of cube corners from within the array. All the triangular cube corners have the same cant, about 9° face-

more-parallel judged by the squatness of the isosceles triangles of Figure 3, while half are oriented with their isosceles triangles pointing toward the left and half toward the right.

14. Szczech '488 Figures 4A and 4B are sectional views from the same patent's Figure 3. Figure 4A, from left to right, cuts up an edge, down a face, up a face, and down an edge. Figure 4B cuts up a face, down an edge, up an edge, and down a face. In Figure 3, the line indicating the 4B section starts, from left to right, up an edge, down a face, etc., and the line indicating the 4A section also starts up an edge, down a face, etc. If the sectioning lines shown in Figure 3 were obeyed, then Figures 4A and 4B would have to be identical, which they are not. Figures 4A and 4B each illustrate correctly a pair of oppositely oriented face-more-parallel cube corners, being paired face-to-face in Figure 4A and paired edge-to-edge in Figure 4B. There is an error in Szczech '488 Figure 3 in the location of the sectioning line for 4B.

15. Szczech '488 Figures 3, 4A, and 4B are apparently derived from Hoopman U.S. 4,588,258 Figures 3, 4A, and 4B. Below are reproduced the Figures 3 from both patents. The sectioning lines marked 4A are approximately the same in both Figures 3. These sectioning lines are correct, meaning that they concur with the section diagram of Figure 4A in each patent. However the sectioning lines marked 4B are quite different in the two Figures 3. They are correct in Hoopman '258 Figure 3, but not in Szczech '488 Figure 3. Aside from this unfortunate labeling error, Szczech '488 ilustrates the same array of face-more-parallel triangle cube corners and illustrates the same pair relations as Hoopman '258.

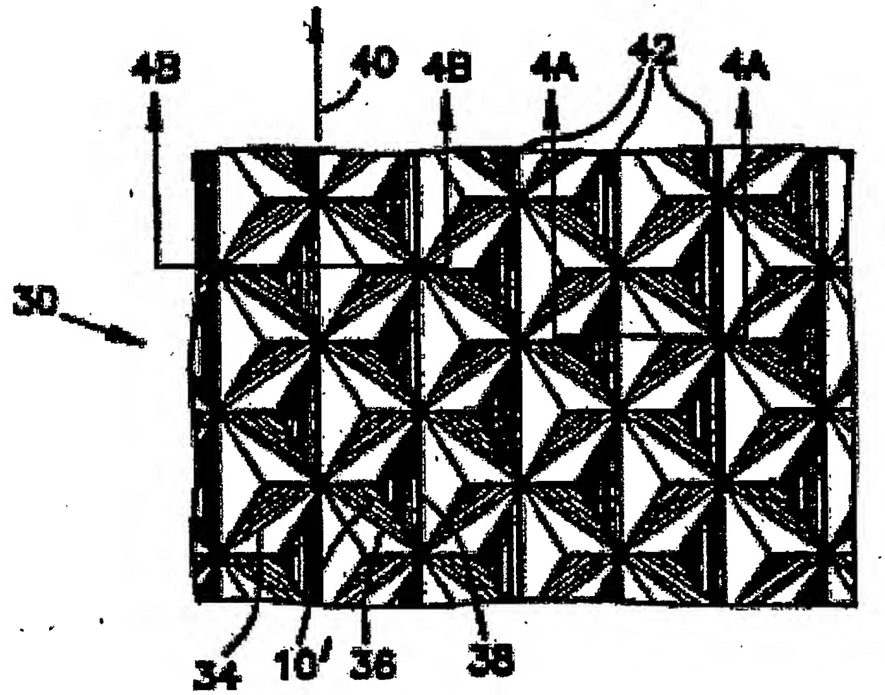

FIG. 3

in Szczech 5,138,488

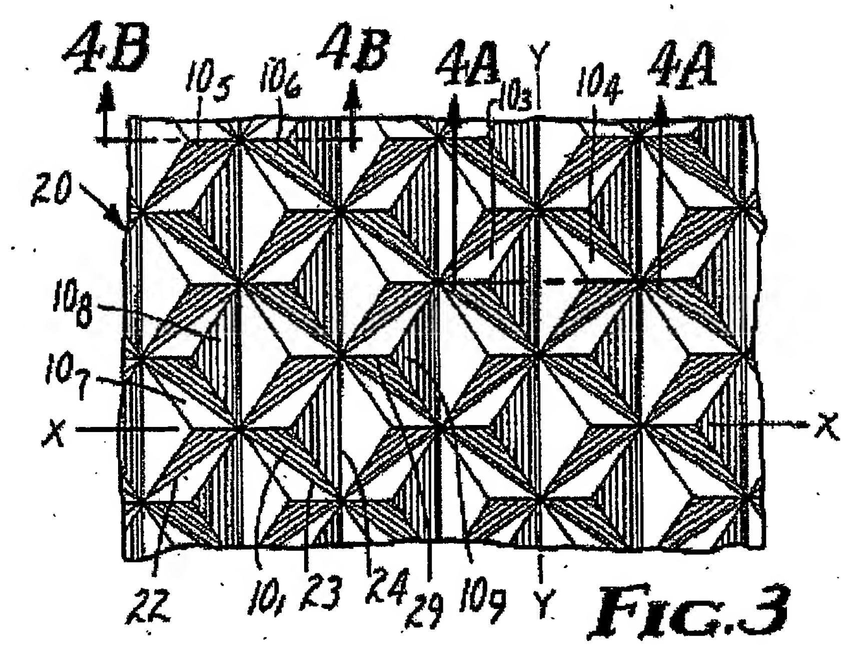

FIG.3

in Hoopman 4,588,258

The undersigned being warned that willful false statements and the like are punishable by fine or imprisonment, or both, under 18 U.S.C.. 1001, and that such willful false statements and the like may jeopardize the validity of the application or document or any registration resulting therefrom, declares that all statements made of his own knowledge are true; and all statements made on information and belief are believed to be true.

Dated: Aug 18, 2003

Dennis I. Couzin